of that absorbed by the inertia of the car. Although a battery has already been able to drive a car 100 miles with one charge, we are waiting patiently for the real automotor storage cell.

Electricity in War.

A strong contingent of electrical engineers, under the command of Major Crompton, has volunteered for service in South Africa. They are all scientifically-trained practical young engineers. Bicycles, field telegraphs, telephones, arc and glow-lamps, cables, search-lights, traction-engines and generating plant will be under their care. It is strongly hoped that we may soon hear good accounts of their performances at the front.

Electricity has been extensively applied to the development and utilisation of explosives in both the civil and military divisions of our profession. Charges are safely fired under water and blasted in mining and demolition operations by small exploding dynamos, magnetic-electric machines or induction coils acting upon high tension fuses. Sir Frederick Abel has especially distinguished himself in this direction. His fuse, composed of phosphoride and subsulphide of copper, is universally used by our War Department. Time guns are thus fired at stated hours at different sea-ports by currents originating in Greenwich Observatory. Broadsides in battleships and guns in turrets are similarly discharged. Torpedoes are even directed by currents from the shore. The defence of our coasts by submarine mines and their explosion by currents when the enemy's ships are properly located by position-finders is the last development of the application of electricity to war.

Electrical blasting has revolutionised the operations of tunnelling and driving galleries. It is much used in quarrying with great security to the men. The deepening of harbours and channels, and the removal of obstructions such as wrecks and rocks, are facilitated. On September 23, 1876, 63,135 cubic yards of solid rock were completely demolished by one discharge at Hell Gate in East River, New York. The preparation for this great blast took four years and four months. There were 4427 charged holes, each containing its mercury fulminate fuse and charges of dynamite. There were 49,914 explosions used in that one blast. Batteries were used to generate the currents, and they were arranged in large groups. Each battery exploded 160 charges. This was the record blast,

The battleship is the home of electricity. It controls the rudder, it ventilates the interior and the living space of the ship, it forces the draught and assists the raising of steam, it revolves the turrets, it trains and controls the fans, it handles the ammunition, it purifies the drinking water, it lights up the ship internally, it enables the captain to sweep the horizon with the brilliant rays of the search-light, and to communicate with his tender or with his commanding officer across space independent of weather, night, season, fog or rain.

Sanitation.

No branch of our profession fulfils the true function of the engineer more efficiently than that which deals with sanitation. Pure air, pure water, pure food, pure soil, pure dwellings, and pure bodies are the panacea for health and comfort. Electricity helps us very much in attaining some of these qualities An electric glow-lamp does not vitiate the air. It does not throw into circulation in the air any product of combustion. The question of ventilation is very much reduced in importance and rendered more simple to effect. Much less air need pass through our sitting-rooms and meeting-places. The air vitiated by our lungs can be easily withdrawn and fresh air can be forced in by fans worked by electric motors. Even the air during its entrance can be warmed, and impurities floating in it can be sifted out of it by the attraction of electrification. Heating by Dowsing's luminous electric radiators is very much on the increase; they consume 250 watts, which cost about a halfpenny per hour. In many post-offices sealing-wax is melted and kept in a liquid state by currents. Water can be sterilised by ozone, a product of electrification, and even by the nascent oxygen, when broken up into its constituent elements by electric currents. Sea-water thus electrolysed supplies us with chlorine, and converts the water into a powerful antiseptic, disinfectant and deodoriser.

Weaving.

The applications of electricity to other industrial processes are innumerable. I have time to mention only one. Mr. T. A. B. Carver has brought out a new Jacquard loom for weaving; 600 hooks are controlled electrically. The twill as well as the pattern is under complete management. It has been warmly taken up in Glasgow, and a factory has been started there.

The pattern on this cloth is woven directly from a photo-print of the artist's design, mounted on a metallic sheet; the threads of the warp being picked up by electromagnetic action, owing to the figure of the pattern being cut away, and thus allowing the circuit to be completed by the metallic sheet.

Distinction between Physicists and Engineers.

There is now a distinct line of demarcation separating the physicist from the engineer. The former dives into the unknown to discover new truths; the latter applies the known to the service of man. Research is the function of the one; utility that of the other. In the past the engineer had to rely on himself for his facts, but the advance of modern science, the growth of technical education, the formation of laboratories, and the endowment of chairs have changed all that.

We can scarcely hope for new sources of energy to be discovered, but there are some existing ones we have not touched yet. When the evil day arrives for our coal supplies to give out we may perhaps be able by the aid of electricity to utilise the heat of the sun and the tides of the ocean. There is, however, a vast illimitable store of energy not only in the rotation of the earth upon its axis, but in the internal heat of this globe itself. As we descend, the temperature gets higher and higher. It ought not to be difficult to reach such temperatures that by thermo-electric appliances we might convert the lost energy of the earth's interior into some useful electric form.

THE SIGNIFICANCE OF THE INCREASED SIZE OF THE CEREBRUM IN RECENT AS COMPARED WITH EXTINCT MAMMALIA.[1]

IT has occurred to me that in order, at short notice, to take part in the celebration of the Biological Society of Paris—however briefly—I might place before my colleagues a biological problem and suggest a solution of it which, though not decisive, has, I think, much in its favour, and raises many interesting points for observation and discussion. It is well established that the extinct Mammalia of the Middle and Lower Tertiaries had—as compared with their nearest living congeners—an extremely small cerebrum. The exact figures are not important, but Titanotherium—a true Rhinoceros—had certainly not more than one-fifth of the cerebral nervous substance which is possessed by living Rhinoceros. Dinoceras representing a distinct group of Ungulata had even a smaller brain. Yet in bulk these animals were as large as, or larger than, the largest living Rhinoceros. Further, it appears from the examination of the cranial cavities of extinct and recent Reptiles, that the increase in the size of cerebrum is not peculiar to Mammalia, but that we may assert as a general proposition that recent forms have a greatly increased bulk of cerebrum as compared with their early Tertiary or mesozoic fore-bears.

It appears also that the relative size of the cerebrum in man and the anthrapoid apes may be cited here as a similar phenomenon; the more recent genus Homo having an immensely increased mass of cerebral nerve-tissue as compared with the more ancient pithecoid genera.

The significance of this striking fact—viz. that recent forms have a cerebral mass greatly larger than that of extinct forms (probably in every class of the animal kingdom)—has not been discussed or considered as it deserves. We cannot suppose that the extinct Rhinoceros, Titanotherium, was really defective in the essential control of its organisation by the cerebral nerve-centres. Probably could we see the two creatures alive side by side, we should not detect any defect in the manifestations of the nervous system in Titanotherium as compared with Rhinoceros; just as we do not remark any such obvious inferiority when we compare a lizard and (let us say) a mouse. The organism with the lesser cerebrum is in each case, in spite of the smaller mass of cerebral nerve-tissue, an efficient and adequate piece of living mechanism.

In what then does the advantage of a larger cerebral mass consist? What is it that the more recent Mammalia have

[1] By Prof. E. Ray Lankester, F.R.S. Reprinted from the "Jubilee Volume of the Société de Biologie of Paris, 1899.

gained by their larger brains? Why has there been this selection in all lines of animal descent of increased cerebral tissue?

I think we gain a key to the answer to this question by a consideration of the differences of cerebral quality between man and apes. Man is born with fewer ready-made tricks of the nerve centres—those performances of an inherited nervous mechanism so often called by the ill-defined term "instincts"—than are the monkeys or any other animal. Correlated with this absence of inherited ready-made mechanism, man has a greater capacity for developing *in the course of his individual growth* similar nervous mechanisms (similar to but not identical with those of "instinct") than any other animal. He has a greater capacity for "learning" and storing his *individual* experience, so as to take the place of the more *general* inherited brain-mechanisms of lower mammals. Obviously such brain-mechanisms as the individual thus develops (habits, judgments, &c.) are of greater value in the struggle for existence than are the less specially-fitted instinctive in-born mechanisms of a race, species or genus. The power of being educated—"educability" as we may term it—is what man possesses in excess as compared with the apes. I think we are justified in forming the hypothesis that it is this "educability" which is the correlative of the increased size of the cerebrum. If this hypothesis be correct—then we may conclude that in all classes of Vertebrata and even in many Invertebrata—there is and has been a continual tendency to substitute "educability" for mere inherited brain-mechanisms or instincts, and that this requires increased volume of cerebral substance. A mere spoonful of cerebral tissue is sufficient to carry abundant and highly efficient *instinctive* mechanisms from generation to generation; but for the more valuable capacity of elaborating *new* brain-mechanisms in the individual as the result of the individual's experience of surrounding conditions, a very much larger volume of cerebral tissue is needed.

Thus it seems probable that "educability" has increased in those Mammalia which have survived. The ancient forms with small brains though excellent "automata" had to give place, by natural selection in the struggle for existence, to the gradually increasing brains with their greater power of mental adaptation to the changing and varied conditions of life: until in man an organism has been developed which, though differing but little in bodily structure from the monkey, has an amount of cerebral tissue and a capacity for education which indicates an enormous period of gradual development during which, not the general structure, but the organ of "educability," the cerebrum, was almost solely the objective of selection.

Two lines of speculation and inquiry are strongly affected by the hypothesis thus sketched.

Firstly, as to the general laws of progressive development of bodily structure by the operation of natural selection—is it not probable that in various groups of animals, just as in the case of man among the Primates, the operation of natural selection on bodily structure (limbs, teeth, hair, horns, &c.) must have been checked, or even altogether suspended, by the transference of selection to the all-important organ of educability, the cerebrum or corresponding nerve-centres? Adaptation by means of the mental powers must take the place of adaptation of bodily structures. The educable animal leaves the ground and learns to climb trees in order to gain its food, whilst in another race the slower process of alteration of bodily form is evolving a long neck to reach the green twigs, or a ponderous strength of limb which can pull trees to the ground. Many similar cases will suggest themselves to the reader in which, even in lower animals, the capacity of learning by experience must (as it were) defeat and turn from its route the otherwise triumphant transformation of bodily structure.

Secondly, the question of the transmission of acquired characters is largely touched by these speculations. The character which we describe as "educability" can be transmitted, it is a congenital character. But the *results* of education can *not* be transmitted. In each generation they have to be acquired a-fresh, and with increased "educability" they are more readily acquired and a larger variety of them. On the other hand, the nerve-mechanisms of instincts are transmitted, and owe their inferiority as compared with the results of education to the very fact that they are *not* acquired by the individual in relation to his particular needs, but have arisen by selection of congenital variation in a long series of preceding generations.

To a large extent the two series of brain-mechanisms, the "instinctive" and the "individually acquired," are in opposition to one another. Congenital brain-mechanisms may prevent the education of the brain and the development of new mechanisms specially fitted to the special conditions of life. To the educable animal—the less there is of specialised mechanism transmitted by heredity, the better. The loss of instinct is what permits and necessitates the education of the receptive brain.

We are thus led to view that it is hardly possible for a theory to be further from the truth than that espoused by George H. Lewes and adopted by George Romanes, namely that instincts are due to "lapsed" intelligence. The fact is that there is no community between the mechanisms of instinct and the mechanisms of intelligence, and that the latter are later in the history of the development of the brain than the former, and can only develop in proportion as the former become feeble and defective.

These few lines—for the abruptness of which I apologise—will, I trust, serve to show the interesting nature of the speculations connected with the significance of the size of the cerebrum in various Mammalia and other animals. Some of the suggestions obtained from a consideration of the subject will, if carried out in detail, be found of first-rate importance in building up the science of comparative psychology.

ZONES IN THE CHALK.

THE philosophical observations on the genus *Micraster*, which were communicated by Dr. A. W. Rowe to the Geological Society in 1899, have been followed by the publication of his special researches on the zones of the white chalk on the coasts of Kent and Sussex. This second most valuable essay has been communicated to the Geologists' Association (*Proceedings*, vol. xvi. March 1900), who are to be congratulated on having such an addition to their published works. The paper follows along the lines so ably sketched out more than twenty years ago by Dr. Barrois; and Dr. Rowe, in nearly all cases, confirms the previous zonal distinctions and largely increases our knowledge. He shows how invaluable it is to collect stage by stage, and to pay the closest attention to the minute changes which the fossils, and particularly the Micrasters, undergo. The paper is essentially a zoological one, invaluable in indicating the succession of life, and as a contribution towards the genesis of species.

The ordinary subdivisions of lower, middle and upper chalk, which are important when we deal with purely geological problems, are not here dealt with; but the author, who apparently takes little interest in stratigraphy apart from fossils, admits that "we can generally recognise the zones from the appearance of the chalk alone, and that the fossils act as confirmatory evidence." This, indeed, is the experience of those who have worked at zones, and it is only by utilising properly all the evidence that satisfactory results can be obtained. Lithological evidence, often invaluable, is essentially local; the palæontological evidence, so ably and exhaustively dealt with by Dr. Rowe, is clear and uniform throughout the areas with which he deals The fossils, as he remarks, "never fail us,"—that is to say, when you find them, their testimony is safe after the experience he has gained. He has been fortunate in having such an excellent series of sections to work at, and these are well depicted in two folding plates, drawn by Mr. C. Davies Sherborn. Inland, of course, the observer has only a pit-section or road-cutting here and there to act as a guide to the zonal divisions, but no doubt with the aid of the clear descriptions given by Dr. Rowe, and of the ascertained thicknesses of the several zones, it might be possible and even desirable to trace inland their approximate boundaries, if any useful purpose were thereby gained. In any case, Dr. Rowe's work will be appreciated alike by field-geologists and palæontologists. Prof. J. W. Gregory describes a new Echinoderm, and Dr. F. L. Kitchin describes a new species of *Terebratulina* from the chalk.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. R. H. Yapp has been appointed assistant curator of the Herbarium under Prof. Marshall Ward.

Prof. Clifford Allbutt was on April 23 appointed physician to Addenbrooke's Hospital, in accordance with the recent agreement between the University and the governors.

Dr. Adami and Mr. de Soyres have been appointed delegates